

### Features

- Optimized performance for medium operating frequencies up to 5 kHz in hard switching
- Low on-voltage drop ( $V_{CE(sat)}$ )

### Application

- Motor drive

### Description

This IGBT utilizes the advanced PowerMESH™ process resulting in an excellent trade-off between switching performance and low on-state behavior.

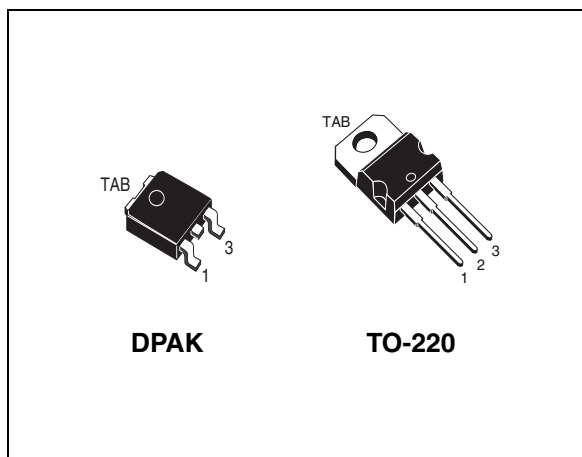


Figure 1. Internal schematic diagram

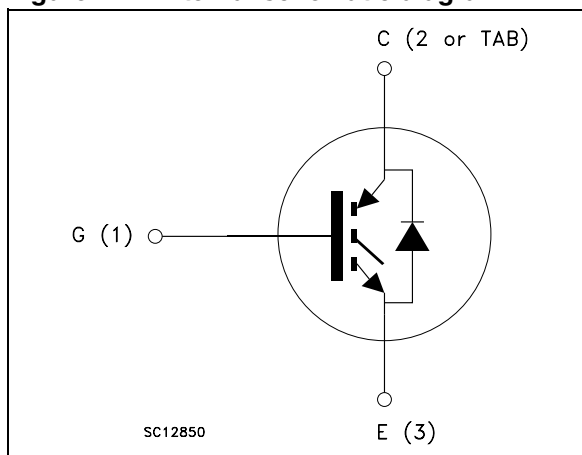


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGD10NC60ST4	GD10NC60S	DPAK	Tape and reel
STGP10NC60S	GP10NC60S	TO-220	Tube

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		DPAK	TO-220	
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GE</sub> = 0)	600		V
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 25°C	18	21	A
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 100°C	10	11	A
I <sub>CL</sub> <sup>(2)</sup>	Turn-off latching current	14		A
I <sub>CP</sub> <sup>(3)</sup>	Pulsed collector current	25		A
V <sub>GE</sub>	Gate-emitter voltage	±20		V
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	60	62.5	W
T <sub>j</sub>	Operating junction temperature	-55 to 150		°C

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

2. V<sub>clamp</sub> = 80%.(V<sub>CES</sub>), T<sub>j</sub> = 150 °C, R<sub>G</sub> = 10 Ω, V<sub>GE</sub> = 15 V  
 3. Pulse width limited by maximum junction temperature and turn-off within RBSOA

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		DPAK	TO-220	
R <sub>thJC</sub>	Thermal resistance junction-case	2.08	2	°C/W
R <sub>thJA</sub>	Thermal resistance junction-ambient	100	62.5	°C/W

## 2 Electrical characteristics

$T_J = 25\text{ °C}$  unless otherwise specified.

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage ( $V_{GE} = 0$ )	$I_C = 1\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 5\text{ A}$ $V_{GE} = 15\text{ V}$ , $I_C = 5\text{ A}$ , $T_J = 125\text{ °C}$		1.45 1.45	1.65	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 250\text{ }\mu\text{A}$	3.75		5.75	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}$ , $T_J = 125\text{ °C}$			150 1	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15\text{ V}$ , $I_C = 5\text{ A}$		3.5		S

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0$	-	365	-	pF
$C_{oes}$	Output capacitance			44		
$C_{res}$	Reverse transfer capacitance			8		
$C_{res}$	Reverse transfer capacitance			8		
$Q_g$	Total gate charge	$V_{CE} = 480\text{ V}$ , $I_C = 5\text{ A}$ ,	-	18	-	nC
$Q_{ge}$	Gate-emitter charge	$V_{GE} = 15\text{ V}$		8		
$Q_{gc}$	Gate-collector charge	<a href="#">Figure 16</a>		3.5		

**Table 6. Switching on/off (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ $R_G = 10\text{ }\Omega$ , $V_{GE} = 15\text{ V}$ , <a href="#">Figure 17</a>	-	19	-	ns
$t_r$	Current rise time			4		
$(di/dt)_{on}$	Turn-on current slope			1330		
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ $R_G = 10\text{ }\Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ °C}$ <a href="#">Figure 17</a>	-	18	-	ns
$t_r$	Current rise time			4.5		
$(di/dt)_{on}$	Turn-on current slope			1000		
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ , $R_G = 10\text{ }\Omega$ , $V_{GE} = 15\text{ V}$ , <a href="#">Figure 17</a>	-	100	-	ns
$t_{d(off)}$	Turn-off delay time			160		
$t_f$	Current fall time			205		
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ , $R_G = 10\text{ }\Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ °C}$ <a href="#">Figure 17</a>	-	165	-	ns
$t_{d(off)}$	Turn-off delay time			250		
$t_f$	Current fall time			310		

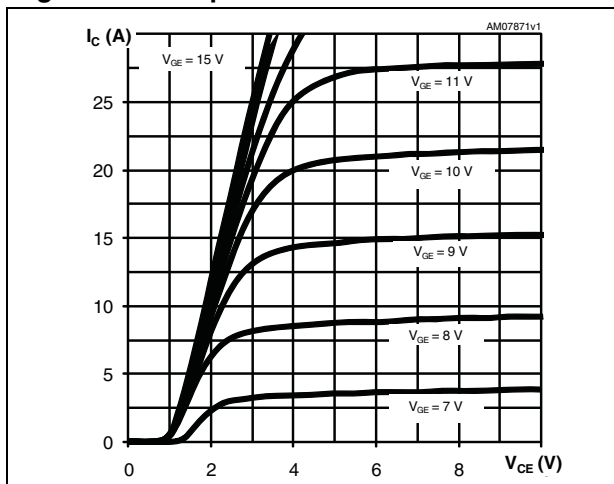
**Table 7. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 480\text{ V}, I_C = 5\text{ A}$		60		$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$ <i>Figure 15</i>	-	340	-	$\mu\text{J}$
$E_{ts}$	Total switching losses			400		$\mu\text{J}$
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 480\text{ V}, I_C = 5\text{ A}$		90		$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$ $T_J = 125^\circ\text{C}$ <i>Figure 15</i>	-	540	-	$\mu\text{J}$
$E_{ts}$	Total switching losses			630		$\mu\text{J}$

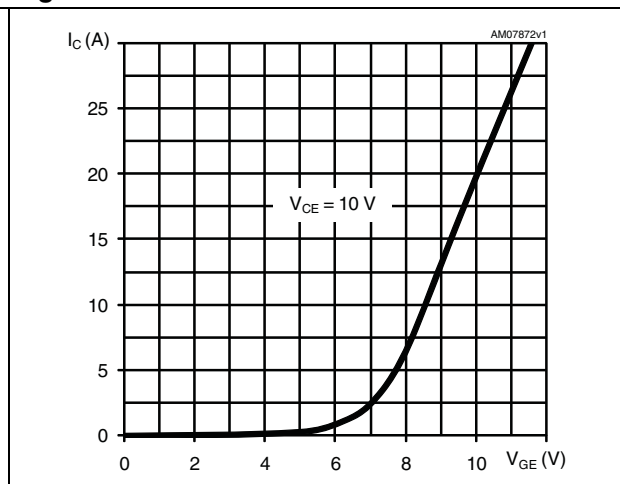
1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in *Figure 15*. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs and diode are at the same temperature
2. Turn-off losses included also include also the tail of the collector current

## 2.1 Electrical characteristics (curves)

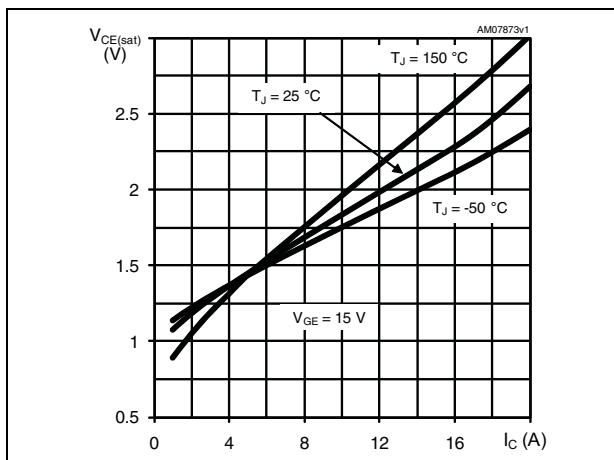
**Figure 2. Output characteristics**



**Figure 3. Transfer characteristics**



**Figure 4. Collector-emitter on voltage vs. collector current**



**Figure 5. Collector-emitter on voltage vs. temperature**

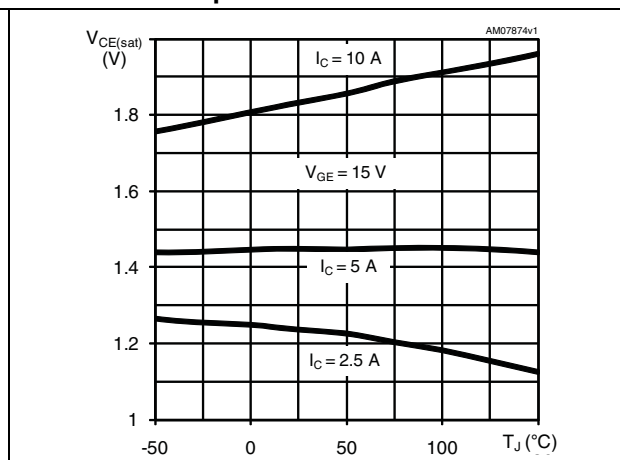


Figure 6. Normalized breakdown voltage vs. temperature

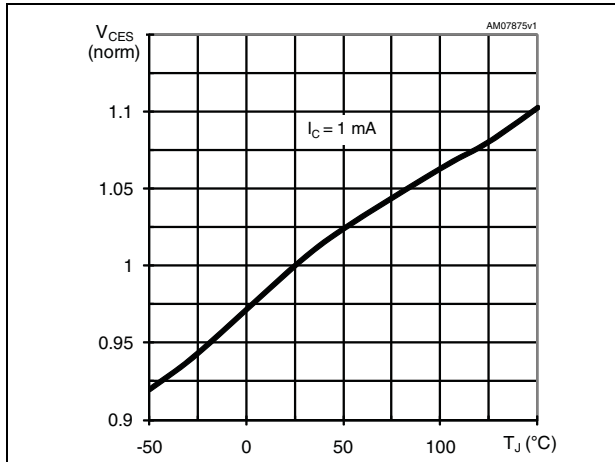


Figure 7. Normalized gate threshold voltage vs. temperature

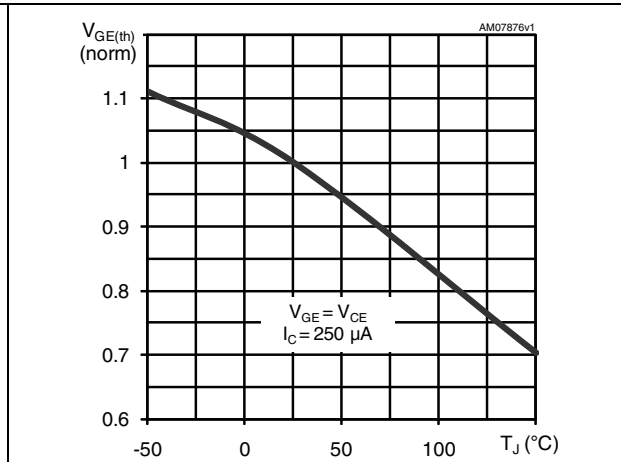


Figure 8. Gate charge vs. gate-emitter voltage

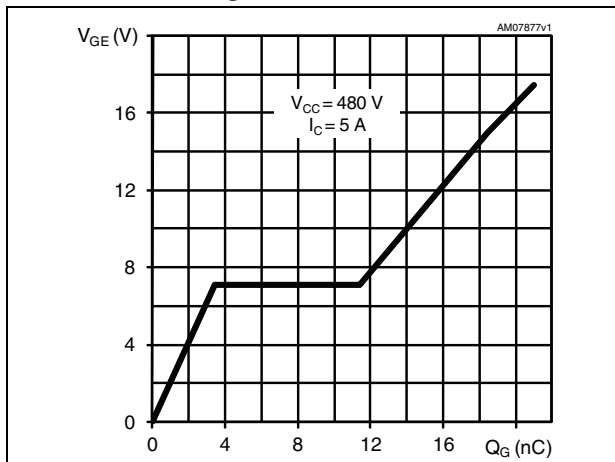


Figure 9. Capacitance variations

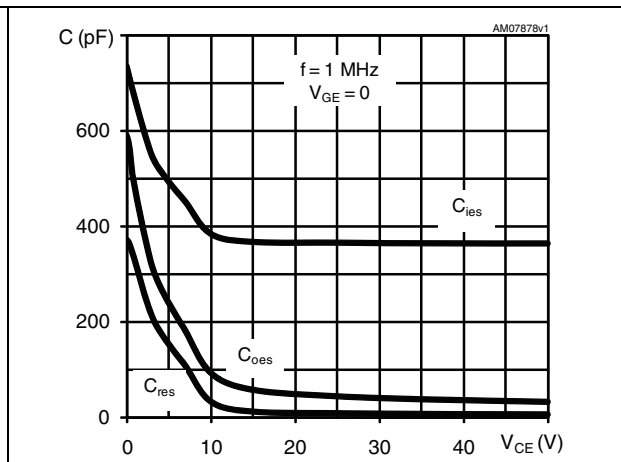


Figure 10. Switching losses vs. temperature

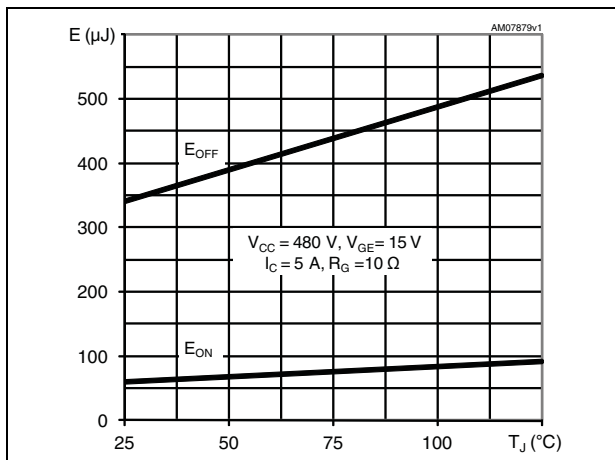


Figure 11. Switching losses vs. gate resistance

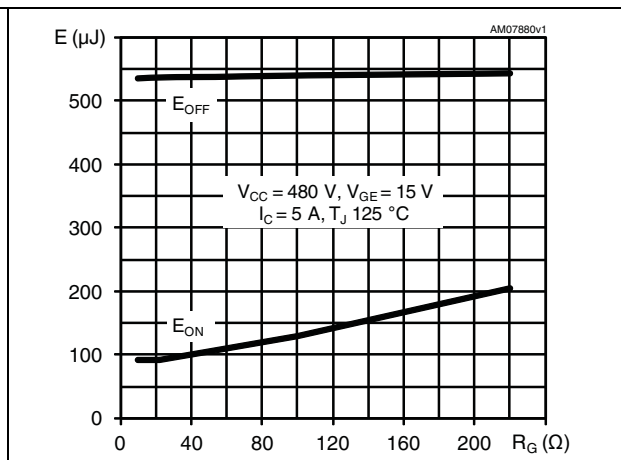


Figure 12. Switching losses vs. collector current

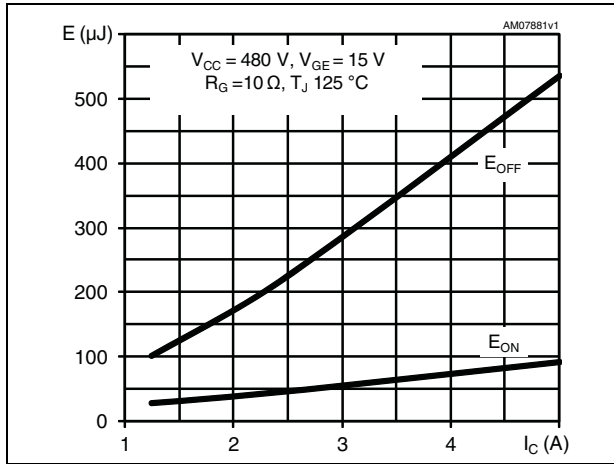


Figure 13. Turn-off SOA

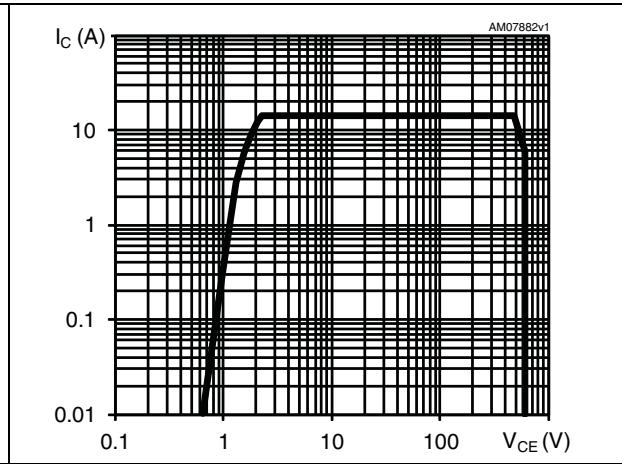
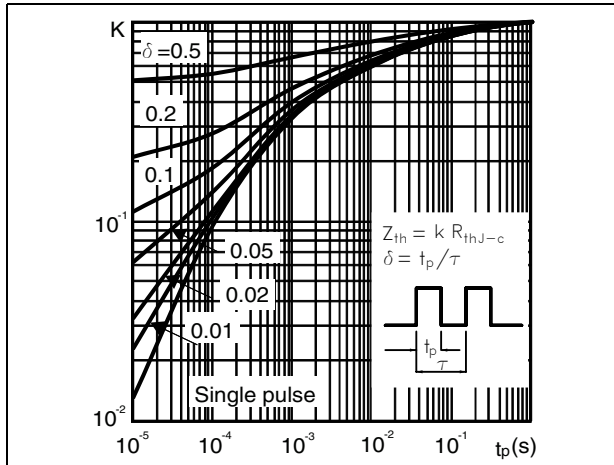


Figure 14. Thermal impedance for DPAK and TO-220



### 3 Test circuits

Figure 15. Test circuit for inductive load switching

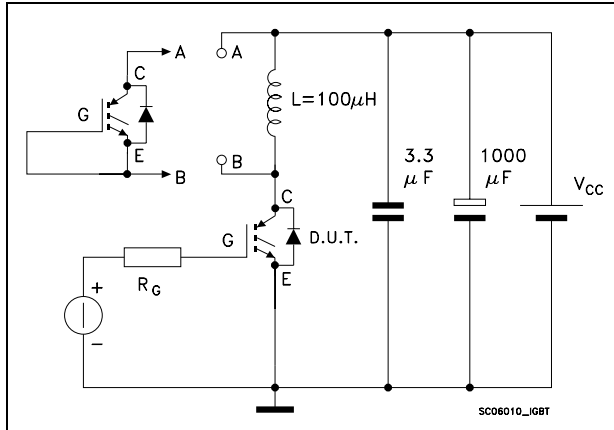


Figure 16. Gate charge test circuit

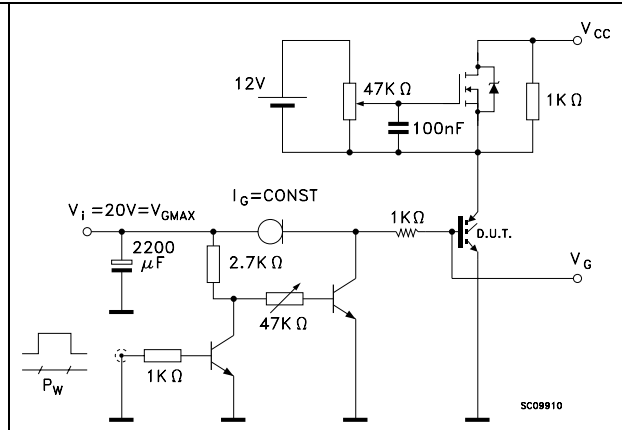
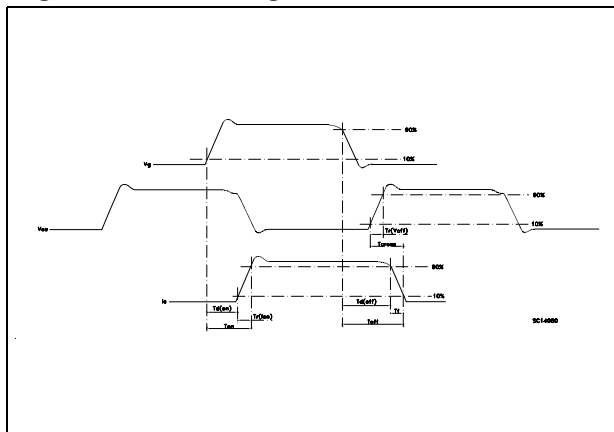


Figure 17. Switching waveforms





## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

Table 8. DPAK (TO-252) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°

Figure 18. DPAK (TO-252) drawing

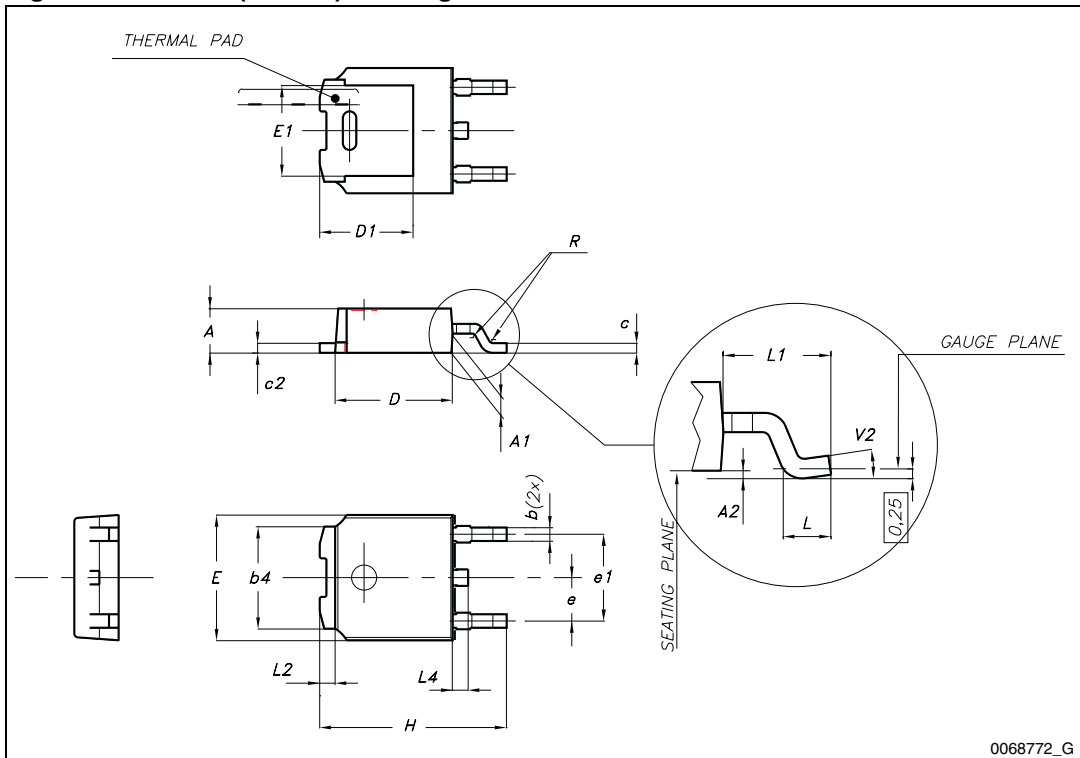
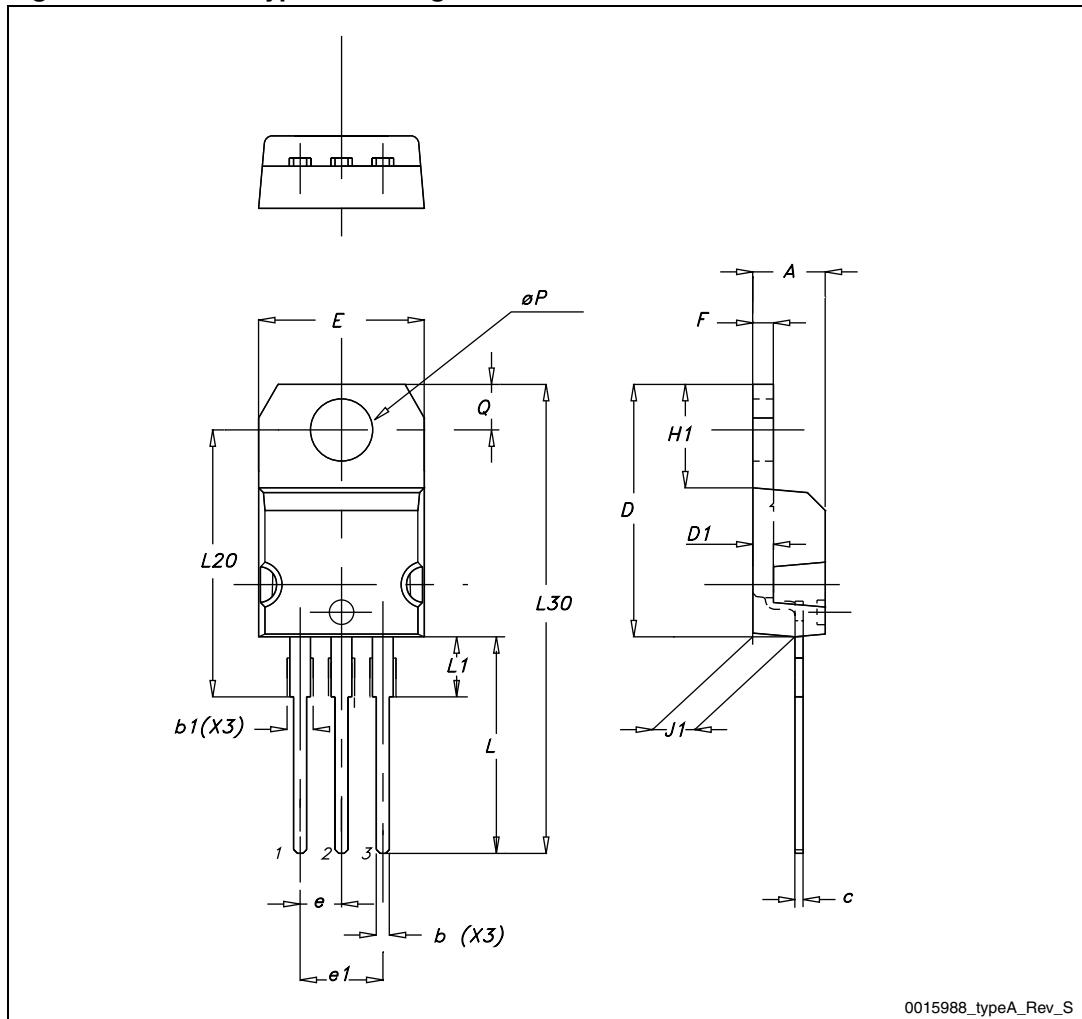


Table 9. TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95

Figure 19. TO-220 type A drawing

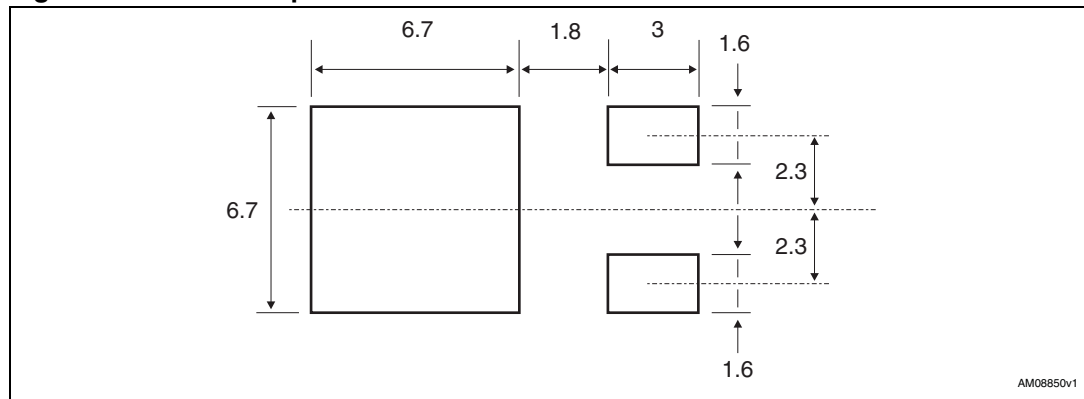


## 5 Packaging mechanical data

Table 10. DPAK (TO-252) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

Figure 20. DPAK footprint<sup>(a)</sup>



a. All dimension are in millimeters

Figure 21. Tape for DPAK (TO-252)

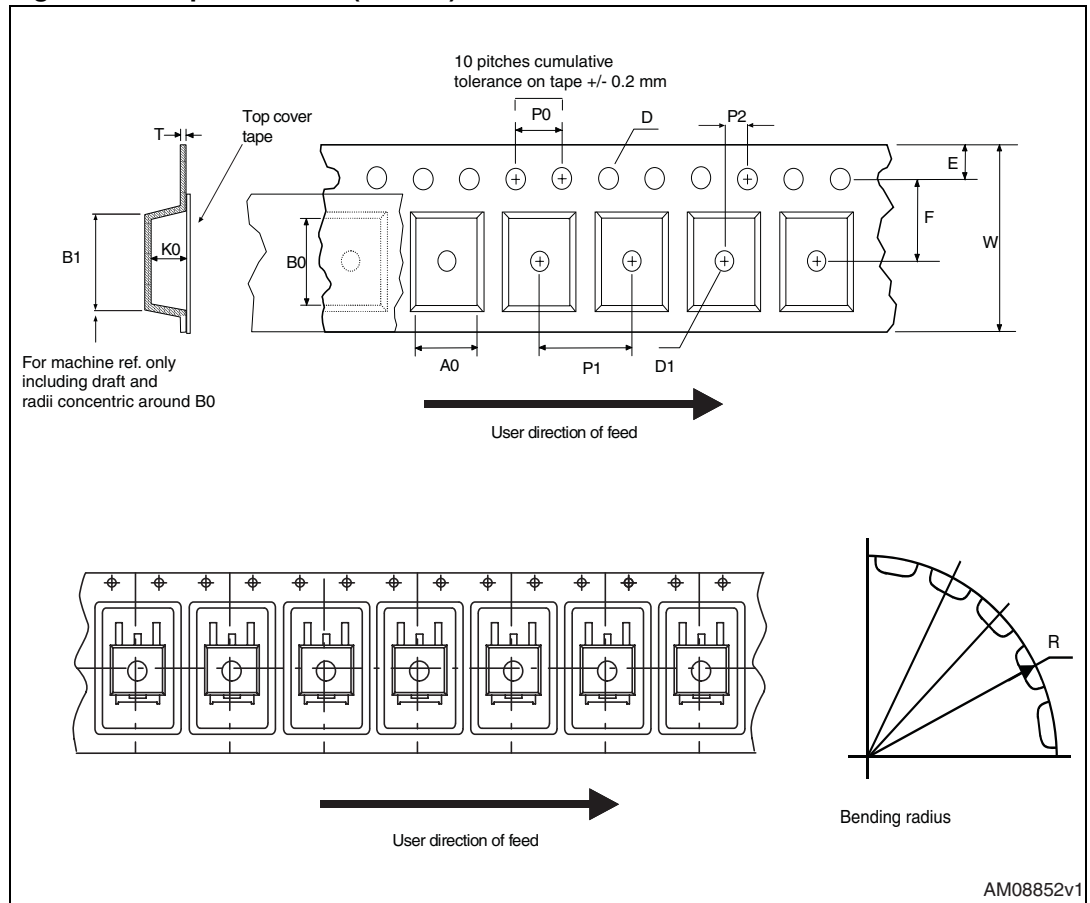
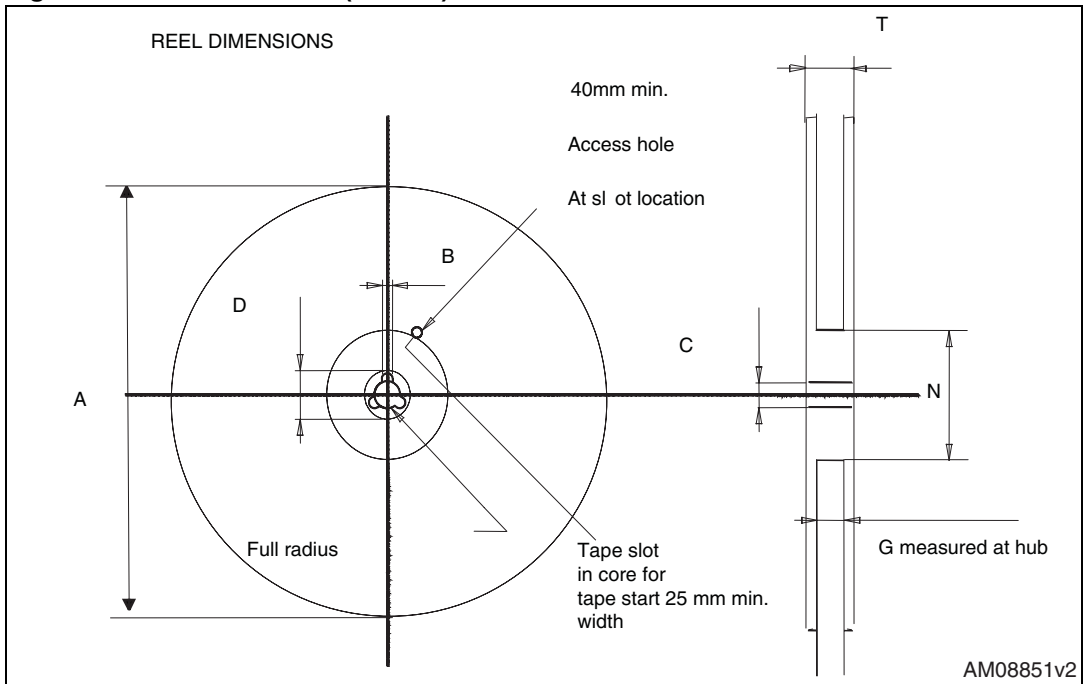


Figure 22. Reel for DPAK (TO-252)





## 6 Revision history

Table 11. Document revision history

Date	Revision	Changes
06-Jul-2009	1	Initial release
17-Dec-2010	2	Inserted <a href="#">Section 2.1: Electrical characteristics (curves) on page 5</a>

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